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## Holographic Photography of High Velocity Particles

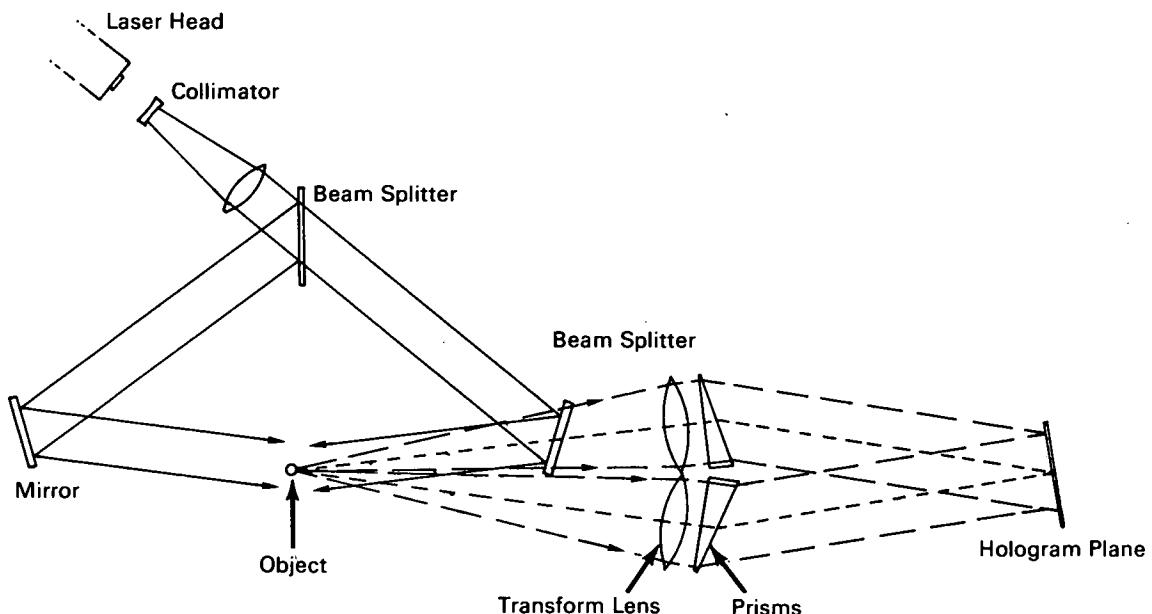


Figure 1. Camera System with Coincident Front and Back Focal Points

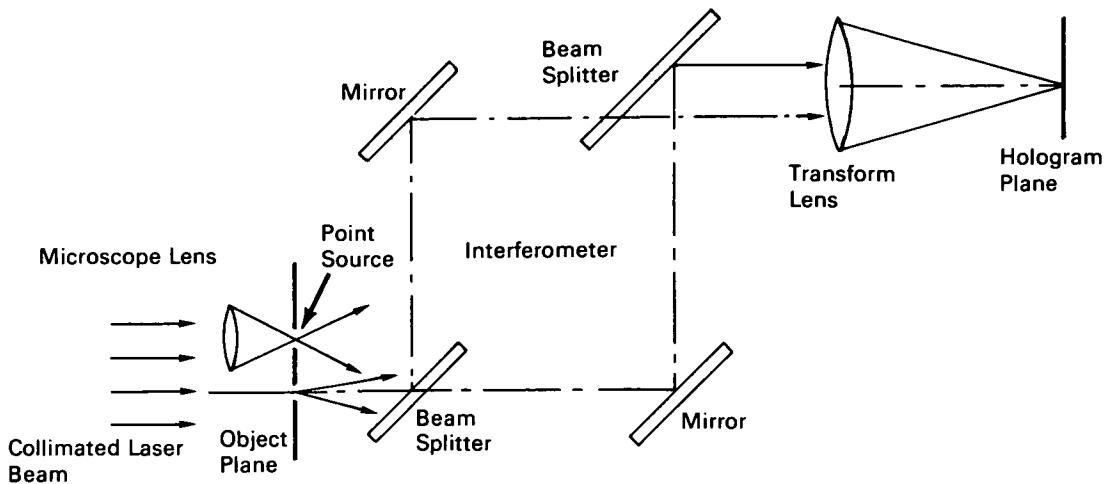
A Fourier transform hologram camera has been designed that is capable of obtaining stationary images of high velocity particles. The primary advantage of the system is its ability to record objects moving with such high velocities that they move even during the short flash duration of a pulsed laser. Consequently, this camera increases the velocity range for holography by a factor of 10 to 1000.

Two different optical systems have been investigated. Both use a triangular arrangement of beam splitters and a mirror to illuminate the object from two directions. Forward-diffracted light becomes the object beam, producing a Fourier transform of

the object in the focal plane of a lens, and back-reflected light is used as the reference beam. These two beams remain mutually coherent as the object is moved. Hence, the primary optical design problem is to produce a fixed angle between the two beams, while maintaining a stationary interference pattern in the Fourier transform plane.

In the design shown on Figure 1, two symmetrical optical systems are arranged so that both front and back focal points are coincident and the optical axes are inclined at an angle. With the object near the intersection of the two front focal planes, the forward-diffracted light travels through the lower optical sys-

(continued overleaf)



**Figure 2. Test Setup for Modified Mach-Zehnder Interferometer System with Coincident Back Focal Planes**

tem, while back-reflected light is collected primarily by the upper system.

In order for this system to yield a stationary hologram, the object's direction of motion must be perpendicular to the two axes and parallel to the intersection of the two front focal planes, within a very close tolerance. A similar situation occurs in any configuration where the object and reference-beam focal planes are inclined. Since such systems produce a stationary image only in a special case, they were not experimentally investigated.

Figure 2 diagrams a test setup using a better optical system for holography of moving objects, in which a modified Mach-Zehnder interferometer is placed between the object and the transform lens. In addition to the diffracted wave from the object, a point reference source is produced in the object plane by a microscope lens. Apertures block the reference beam in the lower arm and the object diffracted beam in the upper arm. The final beam splitter is displaced slightly from its usual position, producing linear interference fringes in the back focal plane of the transform lens. Since parallel beams enter the lens, the front focal planes are parallel and the intensity in the hologram plane remains stationary, independent of the object's direction of motion. This has been verified experimentally.

The final optical system for the hologram camera uses the interferometer of Figure 2 with a plane polarized laser beam and the triangular illumination scheme shown on Figure 1. A 1/4-wave plate is used in one leg of the triangle to rotate the plane of polarization of the forward diffracted beam by 90 degrees. An analyzer in the upper arm of the interferometer passes the reflected reference beam, while in the lower arm,

an analyzer passes the diffracted beam. A second 1/4-wave plate then rotates the plane of polarization back again, so that interference can take place.

#### Notes:

1. Due to limitations on the resolution intrinsic to Fourier transform holography, the interferometer approach appears useful only for high-speed particles 100 microns in diameter or larger. These techniques may interest persons who study relatively large, high-velocity particles such as those in wind tunnels and accelerated systems.
2. The following documentation may be obtained from:

Clearinghouse for Federal Scientific  
and Technical Information  
Springfield, Virginia 22151  
Single document price \$3.00  
(or microfiche \$0.65)

#### Reference:

NASA-CR-86147 (N69-24927), Feasibility Study of Velocity Synchronized Fourier Transform Hologram Camera System

#### Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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